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Social acceptance of ocean wave energy: A case study of an OWC shoreline plant

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Social acceptance, along with technical, economic and legal aspects, is a prerequisite for the successful adoption of renewable energies. Research into the social acceptance of the underlying implementation of different renewable energy technologies, such as grid connected photovoltaic solar, biomass and wind power plants, is increasingly gaining interest. Nevertheless, studies that address the issue of the social acceptance of sea wave energy plants are very rare. This article aims at making a contribution towards filling this gap analyzing the community acceptance of the oscillating water column (OWC) shoreline plant of Mutriku, a facility that has been subject of great interest due to its innovative technical characteristics. This article's findings emphasize the importance of effective and meaningful social involvement in the successful promotion and diffusion of renewable energy infrastructures such as wave energy plants.

Contents

Abbreviations: WE, Wave energy; OWC, Oscillating water column; NIMBY, Not in my back yard; EVE, Energy agency of the Basque Country (Ente Vasco de la Energía); BAG, Basque autonomous government.

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1. Introduction

Though often overlooked, social acceptance is one of the most important requirements for the successful adoption of any technology. Despite the fact that the theoretical importance of social acceptance has been highlighted e.g. [1–4], not until recently have they been given the attention they deserve in the applied studies of renewable energy projects e.g. [5]. This attention has been focused mainly in relation to the acceptance of wind energy infrastructures e.g. [6,7]. Other type of renewable energy projects has not garnered the same amount of vigorous inquiry.

In the specific case of wave energy (WE) projects, issues regarding social and public acceptance have largely been neglected in literature, despite there is growing interest around the world in the utilization of WE technologies [8]. This fact might be due to the particularly positive public opinion that seems to prevail with regard to this source of energy [9,10]. As we′ll see, very few studies have addressed the issue of social acceptance of sea wave plants. This article tries to contribute towards filling this gap focusing in on a specific case study: the grid connected oscillating water column (OWC) plant of Mutriku, a facility whose specific technology exemplifies what made it subject of great international attention. e.g. [8,11,12]. This article summarizes the findings of specific qualitative research carried out recently, where, among many other modes of research, different stakeholders of the aforementioned renewable project were interviewed.

The remainder of this paper is organized as follows. In Section 2, current literature on the social acceptance of renewable energy infrastructures is reviewed. A short overview about the sea WE technology and the context of that research are presented in Section 3, while the specific objectives of the research and its methodology are presented in Section 4. In Section 5, the main findings of the case study carried out are presented. Those results are analyzed and discussed in Section 6. Finally, Section 7 contains the main conclusions and implication of this paper.

2. Social acceptance of renewables and the case of wave energy

The issue of social acceptance of renewable energies and renewable energy projects was largely neglected in the 1980s and 1990s, because of the perceived high level of general public support for renewable energy technologies [13]. Despite this high level of general acceptance, renewable energy projects can be socially rejected, although it might be seen as a contradiction [14].

In Table 1 we have included a review of the most relevant and recent academic literature on social acceptance of renewable energies and renewable energy projects as well as other related

Table 1
Summary of the literature review on the social acceptance of renewable energies, renewable energy projects and related topics.
Source: data collected by authors.

Study	Country	Methodology	Aim of the research	Main results
Achillas et al. [27]	Greece	Face-to-face interviews	Social acceptance for the development of a waste-to-energy facility	The NIMBY syndrome is evidently portrayed between the lines in the analysis. Likewise, responses reflect a significant gap of information at the level of local communities
Bronfman et al. [28]	Chile	Online survey	Validate a causal trust-acceptability model for electricity generation sources	Perceived benefit had the greatest total impact on acceptability, thus emerging as a key predictive factor of social acceptance
Devine-Wright [7]	Northern Ireland	Focus groups and Survey questionnaire	Analyze the importance of place attachment when explaining public responses to a tidal energy project	Place attachment and place-related symbolic meanings emerged as a significant, positive predictor of project acceptance
Dowd et al. [29]	Australia	Participatory action research	Investigate the social acceptance of geothermal technology	Despite the limited understanding of geothermal technology, it receives general support due to a major trend supportive to renewable energy sources
Erbil [16]	Turkey	Survey questionnaire	Analyze the level of understanding of what is clean energy among citizens	The clean energy concept is understood at the theoretical level but more information is needed to foster social acceptance
Gamboa and Munda [30]	Spain	Various participatory techniques	Social acceptance of wind park location	Some of the main factors for local conflicts and opposition to wind parks are the extensive land use, visual impact and fear for potential impacts on the tourism industry
Hall et al. [31]	Australia	Face-to-face interviews	Study the high levels of societal resistance to wind power and wind farms	Four common themes emerged that restrains the social acceptance of wind farms: trust, distributional justice, procedural justice and place attachment
Kraeusel and Möst [32]	Germany	Online survey	Social acceptance of Carbon Capture and Storage (CCS)	The attitude towards CCS is neutral and the social acceptance is an important factor for the willingness to pay for CCS
Liu et al. [33]	China	Survey questionnaire	Examine the social acceptance in the rural areas of renewable energy deployment	Rural residents are generally supportive for renewable energy development. Residents with higher level of income are more likely to be willing to pay more for green electricity, so are the younger people
Müggenburg et al. [34]	Ethiopia	Face-to-face interviews	Social acceptance of Pico Photovoltaic systems as a means of rural electrification	Apart from expected benefits in health, work and education, people also notice improvements in the autonomy of children, flexibility, security, family life and the reduction of stress
Shamsuzzoha et al. [35]	Scotland	Face-to-face interviews and Survey questionnaire	Social acceptability of renewable energy under economical, environmental and cultural perspectives	Involvement of the local community plays a crucial role in determining the acceptability of a renewable energy development
Swofford and Slattery [36]	USA	Survey questionnaire	Explore social perceptions of wind energy in Texas	Findings support the view that the use of NIMBY does not adequately explain the attitudes of local wind farm opposition.
Wolsink [37]	Netherlands	Case-study	A comparative study on three environmental policy domains: 1. The implementation of wind power; 2. The policy on space-water adaptation; 3. Waste policy	Authorities frequently promote infrastructures that conflict with their officially proclaimed policy objectives and they often confront local agents who support alternatives that are in fact more in accordance with the new policy paradigm
Yuan et al. [38]	China	Survey questionnaire	Social acceptance of solar energy technologies	High level of social acceptance and public awareness of solar water heater and low level of acceptance of solar PV

topics. The lit review that we have conducted in this research shows that the topic of social acceptance of renewable energy projects is really complex and multi faceted, due to the fact that many dimensions (social, economic, political…) predictors and different agents are involved, as recently has been stressed by Batel et al. [15].

The literature on social acceptance indicates that there can be a number of dimensions contained in this concept [16]. As stressed by Wolsink [17], social acceptance of renewable energies means acceptance among all relevant actors in society, what implies a much broader and conceptually fully distinguished concept from mere public acceptance. In this sense, the definition by Wüstenhagen et al. [13] represents an important milestone in the specialized academic literature related to social acceptance. These authors distinguished three dimensions of social acceptance of renewable energies [13]: socio-political acceptance, community acceptance and market acceptance. Socio-political acceptance refers to the social acceptance on the broadest, most general level, by the public, by key stakeholders and by policy makers. Market acceptance here refers to the process of the market adoption of an innovation. Finally, community acceptance refers "to the specific acceptance of siting decisions and renewable energy projects by local stakeholders, particularly residents and local authorities" [13]; p. 2685.

In this work, we will focus on that social acceptance approach and in order to analyze it, we will take as reference the theoretical fundamentals established by Walker [1] and Wüstenhagen et al. [13]. In the past decade several studies have focused on the analysis of the community acceptance for some of the renewable energy alternatives, have been published, more specifically, the dichotomy that has been formed between the general public acceptance and the local public opposition For instance, many studies show that while there is a large public support for wind energy, there is a strong opposition against local wind energy project [5,18–20].

When referring to the lack of community acceptance of siting decisions of renewable energy projects by local stakeholders, the most cited explanation, already converted into some sort of *conventional wisdom*, is contained in the acronym NIMBY (Not In My Backyard). It is important to state that the NIMBY approach is not considered an explanatory model. Among the specialists in the field most have moved away from the NIMBY explanation e.g. [21–23] in order to counter the resistance that these projects face. Currently, more sophisticated models are suggested [20,21,24–26].

Although certain levels of credibility are attributed to some elements of the of the NIMBY explanatory model, it is overall seen as too simplistic, an explanation to accommodate the multi-faceted reasoning behind a communized oppositional behavior [26]. In the most recent literature, it is acknowledged that a complex multiplicity of factors, shape and influence the community attitudes towards renewable infrastructures [39]. Among other factors that are context sensitive and time dependent, Warren and McFadyen [26] highlight the relative influence of local perceptions about economic impacts, the national political environment, social influences, and institutional factors such as the perceived inclusiveness and fairness of the planning and development process [26]. In fact, in the scientific literature here referenced, institutional factors seems to be more important than NIMBY-isms, since it has been ascertained that building institutional capital might improve the successful adoption of renewable infrastructures. Institutional capital implies, among other things, knowledge resources, relational resources and capacity for mobilization.

An interesting example of wind turbines siting in Catalonia is described by Gamboa and Munda [30]. In this case, having the affected population participating in the decision-making process of the project, turned out to be a positive enhancer for the social acceptance of the wind park. On the other hand, has to be taken into account that social acceptance is not simply a set of static attitudes of individuals. On the contrary, it is a non-static complex and dynamic social process. As is emphasized by Wolsink [37], it is a dynamic process that is a result of learning processes, and refers to social relationships and organizations.

In summation, it seems to be evident, as pointed out by Wüstenhagen et al. [13], when it comes time for designing, planning and developing renewable energy projects, effective policies are required to address the complex issue of its community acceptance. With a few exceptions [9,10,40–42], the WE community acceptance study has not been subject to enough rigorous attention. Indeed, the academic community has identified social and public perception as a non-critical barrier of WE. Hansen et al. [40] comment that WE can possibly become more popular than wind energy because of the minimized visual and noise impact. Nevertheless, as Bailey et al. [10] recently pointed out, ocean WE is an emerging technology, and many consequences of its impacts are unlikely to be well understood for several years following the construction of these facilities. As stressed by Fernandez-Chozas et al. [43], since the public is now having its first acquaintance with WE, the sooner there is an effective approach to WE, the more opportunities will there be for the WE sector. As a result, different players promoting this technology must be aware of the importance of establishing a fruitful relationship with all the project stakeholders here this refers to those involved in the existing array of ocean uses, such as fishing, recreation, transportation, aesthetics, and marine life conservation [9].

As far as we know, no previous empirical studies have addressed the specific issue of the community acceptance of a WE shoreline plant. It is only possible to source a few brief and descriptive studies conducted by Fernandez-Chozas et al. [43]. Similar to these studies, but focused on a very different project, technologically speaking, is the in-depth study of the place attachment and place-related symbolic meanings when explaining public responses of a grid-connected tidal energy convertor carried out by Devine-Wright [42]. In deed, given the very specific technical characteristics of the OWC plant in Mutriku, and considering as well the complex process of development and construction of this plant, we believe that an in depth analysis of this case would be of interest to the international community.

3. Research context: Sea wave energy in Spain

The history of WE research spans over more than two hundred years [11,44]. Wave power, among all the types of Ocean Power, is currently in an advanced stage of development. There are a large number of different technologies and existing patents aimed at extracting the energy contained in ocean waves and the OWC is, among all those technologies, one of the most outstanding ones. Nevertheless, currently there is not one prevailing technology, being implemented in most cases prototypes that are too early in their development stage to be commercially viable. As this is the case, it is difficult to envisage which so far of those technologies will become successful in the future. For now, discussions are aimed more towards cost reduction and not as much towards efficiency optimization, mainly due to the high costs of facilities [45]. As stressed by de O. Falcão [11] in general, the development, from concept to commercial stage, has been found to be a difficult, slow and expensive process.

Indeed, based on various technologies, a wide variety of systems has been proposed but only a few full-sized prototypes have been set in open coastal waters [8]; most of these are or were located on the shoreline or near shore [11]. Facilities located in the shoreline have the advantage of an easier installation and maintenance, and do not require deep-water moorings and long underwater electrical cables. Unlike in the case of wind energy, the present situation shows a wide variety of WE systems, at

several stages of development, competing against each other, without it being clear which types will be the final winners [11]. Some of these systems are in function and productive. In Portugal there is a clear commitment towards the WE as an energy resource. As well, in the Iberian Peninsula, Spain has a large WE potential thanks to its long coast shore (over 8000 km). In the coast and the shallow waters of Spain the average energy potential is between 3 and 5 kW/m further out to sea the range has been estimated to be between 10 and 16 kw/m [46].

Due to this, and since the Spanish Public Administration gave strong support to the renewable energies in the years prior to the economic crisis, there are several ongoing projects in Spain that take advantage of this type of energy. The first of these projects was installed in 1994. Is a column device in the thermal power station located in Sabón (La Coruña, Galicia). More recently in 2009, a wave power plant was opened in Santoña, Cantabria. This facility uses technology developed by the company Ocean Power Technologies. That same year in Mutriku (Gipuzkoa), an OWC Plant was opened and connected to the grid. It is a very original project as it is the first OWC commercial plant to be installed in the continental Europe.

4. Research methodology

For the purpose of this paper, empirical study of a qualitative nature was designed based on a case study. This methodology was selected because of its suitability for analyzing the complex processes involved in the adoption of renewable technologies, in which – as already has been stated – diverse agents and actors interact. This is also the methodology recommended for the specific field of the social acceptance of WE [43]. Exploratory research was planned, which would serve to facilitate greater penetration in and understanding of the subject being studied. In this way we planned to detect propositions which are liable to be generalized in terms of the practices observed [47,48]. Furthermore, recent studies have drawn attention to the value of qualitative methods for exploring how renewable energies are perceived and experienced across different social groups, within and across communities, illustrating the complexities of public attitudes and responses [49,50].

The research was developed over time between November 2012 and January 2013, and had two components. First, an in-depth literature review on the case was carried out. Scholar literature, technical literature, gray literature, as well as media outputs were analyzed in this first step. Furthermore, a large amount of documents connected to this project were also analyzed in depth by the three researchers that carried out the study. Alongside these studies, a series of semi-structured in-depth interviews were conducted with different stakeholders related to the Mutriku project.

In particular, twelve in depth interviews were carried out. The sampling process followed a theoretical sampling approach [51,52], as the selection of interviewees was deliberately nonrandom and aimed at interviewing different representatives of the most relevant agents and stakeholders involved in this project. We included an additional criterion to complete the sampling process, which was to sample a group of interviewees whose stances in front of the project could become an accurate representation of the community′s sensitivities [53,54]. The process of identifying potential candidates for the sample of interviewees was conducted by word of mouth; one candidate would suggest others to whom we could talk to and this method proved to be very successful due to the size of the village were the research was conducted. The individual profile of the interviewees is summarized in Table 2. For the agents who were directly involved in the project, we selected those who had the largest experience in what refers to the aim of the survey. Other eight in-depth interviews were held with neighbors of the municipality. We wanted this portion of the sample to be representative of the variety of perspectives found in the community so we would be able to contrast in person all the different discourses held by citizens with regards to the new infrastructure. Having this into consideration, we limited the number of these interviews to 8 because it became clear to us that fewer revelations were made as the interviews were being carried out. As consequence, the possibility of giving rise to theoretical saturation phenomena [55]. The duration of an interview was, as an average, of one hour and a half but they ranged

Table 2
Profile of the interviewes.
Source: data collected by authors.

Interview	Profile	Brief description of the individual and his/ her stance in front of the project
1	Former City Mayor	City Mayor in power during the time the project was carried out. In favor of the infrastructure but critical with some of its technical limitations
2	Council member	Council member representing the Ecologist Party. Against great infrastructures by principle and against the way that the information has been released and the lack of participation of the citizens in the decision making process
3	Project architect adviser	In charge of the Project of the Dam. Technical profile and very much in favor of the infrastructure
4	OWC Project Chief	Technician with a vast background in the field, in charge of the technological leadership of the project. Collected speech, far away from over confidence
5	Retired Ship-owner	Widely acknowledged and prestigious professional. His speech towards the infrastructure is positive in general, although somewhat critical when considering some of the side effects provoked by the construction of the plant
6	Blue-collar operator	This person is highly involved in the community. He has maintained a position against the decision making process used to approve the infrastructure
7	Fisherman	He has more than 30 years of professional experience. He is in favor of the plant. His criticisms for the technical details of the project are supported on strong arguments
8	Student	This person was highly interested on the results of the project. He supported the plant at the beginning but he is now disappointed with the results that the infrastructure has been able to achieve
9	Worker in the service sector	No political or social connection. He supports the infrastructure for its economical performance. This person′s speech is very pragmatic
10	Retired housekeeper	This is a very well known person in the community. She is very active in several cultural and social facets. She is very critical of the local authorities
11	Unemployed	Very judgmental speech against the information and participation policies followed by the developers of the project
12	Public officer	Socially involved in the community and very well known among his neighbors. He supports the project from the beginning. Critical of the ecologist approaches

from one to two hours. The interview protocol used in this research work has been included as an Annex at the end of this article. In order to complete the information obtained from these interviews, the research team visited the municipality several times to enquire, in a more informal and brief manner, into the opinion of different local stakeholders such as beach users, retired fishermen, innkeepers and young students.

As recommended in specialist literature on qualitative inquiry [48,56], the internal validity of the study was guaranteed via the search for common patterns that help to explain the phenomena subject to study. Reliability was ensured via the use of semi-structured interviews of the same type and with the same number of questions an assessment protocol. The information gained from the interviews was triangulated with the broad range of documentation available. We used the grounded theory method of interpretation in order to build responses for our research question based on the data collected along the research project. This method can be suitably integrated with the general methodology of exploratory studies [57]. This is an inductive analytical method with great potential in complex social phenomena such as the one we deal with in our research work, and has been proved successful in previous research in this field [58,59].

5. Results

5.1. Technical characteristics of the plant

Mutriku (5021 inhabitants and a surface of 27.7 km^2) is located in on the west coast of Gipuzkoa, one of the provinces of the Basque Country, located in northern Spain. Founded at the beginning of the 13th century, Mutriku is a town with a large maritime background and history. Not for nothing it was birthplace of eminent sailors such as Cosme Damián de Churruca y Elorza, an Admiral of the Royal Spanish Armada. The port of Mutriku is one of the oldest in Gipuzkoa. In the past years its inhabitants have devoted themselves to whale fishing and the derived industries.

Mutriku harbour stands in a small and narrow natural bay (see Fig. 1). The area is regularly lashed by Biscay storms, which for years have damaged the piers in the harbour [60]. In order to address this problem, the Basque Administration approved a project to build up a breakwater of 440 m, approximately. With the initial project defined, and as part of an overall strategy of developing renewable energy sources, the Basque Government's Department of Transport and Public Works signed a collaboration agreement with the Ente Vasco de la Energía, the Basque energy board to take advantage of construction of this infrastructure to install an ocean energy plant [61].

The startup date for the plant was set for March 2009. The proposed starting point was a breakwater, which already had a finalized design that had been tested in a model, and its administrative procedure had almost been finalized. The original construction project contract had even been awarded [61]. The plant was inaugurated en July 2011. The designed plant has 16 chambers and the upper hole of each chamber has an 18.5 kW nominal power turbo generator attached to it, reaching an aggregate power of 296 kW. The turbines are Wells fixed flux type (see Fig. 2), which are very robust and simple [61]. With an installed capacity of 296 kW and an estimated renewable power production of 600,000 kW h per year, the Mutriku facility represents a technological innovation. As stressed by Torre Enciso [61], it is the only one of its kind with a multi-turbine arrangement connected directly to the power grid distribution where all the electricity produced is flown into the grid. The other two facilities that are found in Portugal and Scotland are at the phase of pilot applications with prototypes, basically oriented towards research, making the plant in Mutriku, Europe's first commercial wave plant (for more information on the Design and construction of the plant infrastructure see 60 and 61). This plant is part of the NEREIDA MOWC project, implemented by a European consortium (Spain, UK, Greece) led by the EVE, the Energy Agency of the Basque country (EVE). This project is intended to demonstrate the successful incorporation of OWC technology with Wells turbine power. The project is aimed at demonstrating its viability for future commercial projects.



Fig. 1. Bird's eye view of Mutriku harbour and the breakwater.
Source: prepared by the authors.



Fig. 2. Wells turbine installed in the plant.
Source: Adapted from [38].

5.2. Summary of findings

Throughout the research we saw the complexity of studying the process of social acceptance of shoreline OWC plant of Mutriku and, more importantly, its clear sense of dynamic social process. In what follows we summarize the main aspects considered in this study, taking into account both the results of the face-to-face interviews we conducted and the documents of the project that we analyzed in-depth. For this purpose, main findings of the interviews were contrasted with the most important findings of the analyzed documents. The presentation of the results is focused on these points because they were the most interesting aspects brought forward by those interviewed and were, as well, featured in the documents which we analyzed.

5.2.1. Planning and development process OWC energy plant

The OWC shoreline plant of Mutriku is a project of a complex planning and design, an issue that has had a significant impact on social acceptance. First, the plant project technically overlapped (or became a part of) another previous project; the construction of a dam at the port. The dam was designed to protect the fleet of local fishing boats (which had 20 units when the project was designed and since then the number has decreased significantly). It was a project that was not able to gather a unanimous consensus of the stakeholders involved, although it was unanimously approved by the City Hall.

This lack of consensus was due to different implications of the construction of this infrastructure. For example, in order to build the new dam it was planned to build a new road parallel to the coast. The current road has collapsed three times since its construction resulting in its final cost greatly exceeding the original budget. The project also required, as it will be discussed later on, to change the location of the existing beach and build a new one. For coastal towns as Mutriku, the beaches have a symbolic and cultural importance. At this point it is important to consider as well, albeit very briefly, that in Basque society there is a special political and social sensitivity to the installation of various types of infrastructure. This sensitivity is the result of a complex socio-political climate.

The specific situation of the complex political governance for the municipality could also be a factor in this case, since in the long period in which the infrastructure project was conceived, deep political changes took place. In any case, there existed in the municipality various structured groups of opposition against the construction of the dam, in particular, multiple environmental groups so called *Berdeak* (ecologists), *Independienteak* (independent groups) a platform called *Hobetu leikez* ("It can be improved", in Basque). However there also exist a platform in favor of building the infrastructure—*Mutriku bizirik* ("Mutriku alive").

When the decision was adopted to modify the breakwater in order to include an OWC plant, the municipal government accepted it, its only objection being the possible extension in time for the conclusion of the project since the breakwater project had already come a long way [60]. At this time, ecologist groups against the construction of the plant indicated that the project had been modified in order to add the OWC plant, with the intention of making the dam project look more appealing through the addition of renewable energy.

Thus these ecologist groups, positioned themselves- according to the project promoters-against the WE plant, simply because they were against the breakwater project. Banding together around this cause, these groups established various legal claims against of construction of the dam and the OWC plant. They argued that there was not an environmental impact study conducted about the plant, among other reasons.

In principle, it seems that public support given to the infrastructure of both the dam and the OWC, was relatively common among the social agents. A survey was conducted in the town to find out the level of support for the construction of the dam. The result of this study was that one out of five people were extremely against the project, one in five were against the project but not radically and two in five were in clear favor. The remaining percentage did not care either way. However, although this survey was capable of indicating public opinion at that moment, as we shall see, it did not adequately investigate the causes and dynamics of the positions cited, as stressed in the literature on the implementation of energy infrastructure renewable [1,50].

The Ecologist groups that have been consulted state that they are not against the plant directly but against the chosen location for the plant and all which that location entails. They note that they are "against the macro projects". As an example, it is pointed out by these groups that the institution which seeks to develop the project-the Basque Autonomous Government- it is not overly concerned for the dam′s impact on the fishing activity of the village. The BAG′s primary objective is tourism, being the final aim the creation of a marina. The coordinator of this group said that although his group′s stance could be seen as a NIMBY position, being as it is a, "widespread position", he would not define it as such. He claims that the position is mainly focused on promoting a more careful selection of the location for this facility, "fully investigating the alternatives and choosing the most appropriate".

Berdeak, which had a favorable representation on the council, formally petitioned that a public consultation take place. This petition accrued more than 700 signatures, but as the council had no jurisdiction to decide the matter, the petition was rejected. As we were told by the ex-Mayor of Mutriku "it was EVE who proposed the opportunity, the people had no say, because it is the Basque Government that controls and decides on the works carried out in the ports of the Basque Country". The division of powers is particularly complex in the Basque region and this limits the ability of municipal institutions′ involvement in such projects.

Through the conducted interviews, it became clear that those community members, who were against the dam, also positioned themselves against OWC plant out of the belief that the project of the plant did not justify the project of the dam. They accused the promoters of trying to make a bad project look good. This proved to be a prevailing belief, of the neighbors, and one which OWC project promoters had to face. It is worth point out that other environmental groups that had no local presence (i.e *Eguzki*) found themselves on the fence, because on one hand it seemed very appealing to have a development in the region aimed at advancing the study of this renewable technology, but on the other hand they understood that these types of facilities should not be used to "justify works that are harmful to the environment". *Eguzki*, therefore, stated that these facilities "should be established where the dams already exist". The representative of the platform against the OWC plant also noted that "although the famous NIMBY is very common" when selecting sites, "the alternatives should be investigated very well, for example Scotland has never been tried to implement [the buoys] in one town in particular". Alternative locations were thoroughly analyzed, to try and find a suitable location in between two towns. Usually the interviewed neighbors felt negative about the plant, expressing variously that "they" or "his town" had been used as an "experiment", or "guinea pig".

5.2.2. The noise issue at the OWC energy plant

At one point in the development of this project noise pollution became one of the most prominent social controversies in Mutriku. Although currently it does not appear to be a notable problem, it has remained alive in the public debate on the existing

infrastructure. From the beginning, the ecologist groups and other groups of citizens who mobilized against this project took the noise issue as one of their main arguments. As stressed by Torre-Enciso et al. [38] it is always possible for anyone, to easily find support on this particular aspect to develop arguments against any public infrastructure. If one accesses YouTube and types the words "Mutriku" and "dragon", two videos are found denouncing the noise "emitted by the turbines" in the OWC plant of Mutriku. Although the issue was addressed, as detailed by the technicians, as a specific problem due to a storm during the process of construction of the plant, a problem that lasted just two or three days, the groups against the breakwater immediately uploaded videos in Youtube and publically denounced the noise caused by the WE plant. Despite the fact that the promoter of the project clearly explained the origin of the specific problem [61], in the town of Mutriku these videos generated concern because of the lack of public education of the reality of the situation. Thus, the people caught on the popular name of "Mutriku's dragon" (*Mutrikuko dragoia*, in the original) to refer to the OWC plant-in a tone set between the irony and comedy-, a dragon that at the time of the aforementioned moment during the construction roared fiercely and that "now moved away but still there".

At this point, the project developers made an interesting move. They accepted responsibility for the error by failing to inform the public at what stage the project was during the time the acoustic problem occurred. In order to solve the problem as soon as possible, they opted to send every villager an education brochure and held a conference to inform the citizens about the project's characteristics. That conference was able to clarify many doubts the neighbors of Mutriku had about the noise impact of the plant. The conference also answered a variety of questions confirming their lack of public knowledge regarding the technical scope of the OWC plant installation. Due to special sensitivity around the noise issue, improvements were implemented in the plant, one of which was the installation of the sound insulation for the steel doors of the entryway.

5.2.3. Local perceptions of profitability and economic impacts of the OWC energy plant

This is perhaps the most prominent aspect of debate that we have observed in our work. The fact that the interviews have been conducted at a time of serious economic crisis could have been particularly influential at this point. Broadly speaking we can say that the consulted stakeholders see no clear economic return of the installation.

Environmental groups opposed to the project say they are in favor of research on new ways to generate energy, but that considering the cost that has already been assumed in this project they feel that the government is "throwing money away" at this point. Their stance is that if the plant in Mutriku should be built as "a pilot, could have been built up with one turbine and not sixteen". As for the profitability of the project, they note that there are other much more mature renewable technologies such as wind energy. For their part, the plant developers assume that this project is considered a pre-commercial development that will hardly be profitable. For the developer, this project is part of a strategic commitment to developing the ocean energy industry in the Basque Country: "It is only from this perspective that we can justify a project whose profitability is still unknown even when it is about to be completed". They justify this being put into practice with economic returns in the longer term, related, among to other factors, to the opportunity for development and specialization in the industry and for developing knowledge of marine energy in the Basque Country. They note, too, that it will make the town of Mutriku a world reference point in marine energy, help in attracting local, regional and even international tourists. In fact, they estimate that about 500 people interested in the project could visit the town every year starting the year that the plant comes into operation. The members of the council are not so convinced in the economic return of this investment. The ex-Mayor of Mutriku pointed out that in his opinion "there is no investment for the people, as they do not gain anything with it and no capital is provided".

Nevertheless, considering what we have been able to validate in our visits to the town, it seems like some attraction has been generated due to the interest aroused by the plant. At the time of writing this paper, there is a plan by the tourist office in the town to organize guided tours of the OWC Energy Plant. Officials behind the project note that due to the interest generated by the plant, the town has been visited by business groups from European countries, experts attending international conferences, technology companies in the energy sector and university groups from all five continents have visited this pioneering center for ideas on energy production. Some of the stakeholders interviewed that are more resistant to the project, understand that these expectations of touristic development are too optimistic. In what refers to the estimation of profitability of the plant, these researchers have had difficulties in obtaining official data of the final cost of the plant. Given the complexity of the construction, the classification of costs is not straightforward. Taking into account the investment on civil engineering (additional cost resulting from alterations to the breakwater design) and electromechanical equipment and other expenses the overall investment estimated by the developer of the project two years before the opening of the plant was budgeted as of 6.4 million euros [61], a figure that by far exceed the initial estimates of Investment in electromechanical equipment and others of € 1.5 M and Extra investment in civil engineering of € 2 M [62]. The project has also received a contribution of about € 831,000 from the European Union, NEREIDA project via the Sixth Research Framework Program (Subprogram of Cost-effective supply of renewable energies).

What is more, in order to calculate the profitability of the project, it is interesting to note a particular problem that appears when estimating the potential income for the plant, due to its innovative nature: the uncertainty about the price at which the renewable energy generated will be sold. Wave energy is not included in the Spanish regulations so far; the tariff for wave power is the same as for hydropower. This would represent a clear legal obstacle for the development of WE, since the same incentive is paid to hydropower, a fully mature energy, and WE, which is still in its infancy. Things being what they were, promoters of the plant applied for a special premium for this project. As noted by Torre-Enciso et al. [60] it is an unfair system, which adds even more uncertainty to the promotion of these new initiatives and it does not seem to be the best way to promote a sector

5.2.4. Environmental impact of the dam that holds the OWC energy plant

Given the characteristics of the project under review, the environmental impact of the dam that holds the OWC Energy Plant also deserves a specific analysis. First, we should note the visual impact of the dam structure, which is not yet complete. It is planned to be extended to provide a more sheltered inner harbor. Moreover, we should also refer to the fact that the construction of the new dock that houses the OWC has had to reshape the inner beach of the town that was (and still is) under the shelter of the levees. The characteristics of the previous and the current beach are different. The current one, given its orientation, and as highlighted by many of the people interviewed and consulted does not have a view of the horizon. This gives it a different than the previous beach, more urban feel beach. The sand of the two beaches are also different, being the sand grain

Table 3
Social acceptance of an OWC energy shoreline plant: summary of the public debate in the Mutriku case-study.
Source: Collected by the authors based on the analysis carried out in the research project.

In favor	Against
• Use of a local renewable energy	• Limited yield
• Additional use of an infrastructure that was going to be built anyway	• The technology has not reached maturity
• Economic benefits for locally-established installations	• Is an expensive proposal
• Fosters the development and specialization of the regional industry	• Environmental impact of the facility
• Fosters the regional R+D activities on WE energy	• Noise generated by the plant
• Attracts professionals fostering local tourism	• Damages suffered by the maritime storms.

found in the previous beach was larger and rougher ("would not stick to the towel"), while the new one features sand brought from a close town.

At this point there is a clear disparity of opinion on what is positive or negative from this change: for some neighbors and for the technical developers, the new beach is bigger and more comfortable, more urban, whereas for others, the beach has clearly lost the charm of the previous beach. In fact there seems to be some opposition from certain villagers towards using the new beach, because of all the changes. The construction has also affected the second beach of the town, the one found more in the exterior. This beach has practically disappeared after running out of sand "just after implanting the [OWC] plant" according to the spokesman of the environmental group. Representatives of the Coast Department at the Basque Government and some of the project technicians, who have been consulted about this impact, state that is due to natural causes. It is noted that in this part of the Cantabrian Sea, beaches are losing sand as a general effect of the ocean currents, while Berdeak, the ecologist group, states that the sand loss is provoked by the change of direction of the waves as a consequence of the new construction. In any case, it is clear that the effects on the beaches have a huge social impact, given the high social repercussion of these elements for the population of these coastal towns.

5.2.5. Physical damage to the OWC energy plant due to storms

Throughout the process of construction and operation of the OWC Mutriku Energy Plant, there have been a number of flaws as a consequence of maritime storms. The technicians of the project note that during the construction of the dam and the plant in the time in between the years 2007 and 2009, there have been up to five storms that were greater than the greatest one in the period of 1990 to 2005. As a result, the initial draft of the dam has had to be reinforced.

Since the start up of the OWC plant there have been several occasions when it has been damaged and had to stop its activity. For example, in December 2011 a severe storm hit the shores of the region and because of this they had to stop the plant for three months. The power generation part of the plant was protected and not harmed, but given that the huge waves topped the dam, the doors of the control house were blown, and the house was flooded. Due to these storms, it was decided replace outer doors with ones made of more robust materials. Because of this damage, the OWC Plant was stopped until March 2012, precisely during the months that this facility it is expected to produce more energy, as it was explained from the developer side. From our perspective, it seems clear that the damage caused by the sea on the plant-a fact that in the culture of a city with historic and cultural ties to the sea such as Mutriku—not only has had an impact on the investment and on the cost of the project but has also eroded its social acceptance.

To summarize the case study, we have gathered the main pros and cons to OWC Mutriku Energy Plant that we have observed and validated, in Table 3.

6. Discussion

The positive overall picture for renewable energy technologies in general, and for the WE supposedly less problematic than other type of energies -has led researchers and policy makers to believe that public acceptance is not an issue. Nevertheless, in this case study it is validated that social acceptance for WE plants is not an issue as simple as it might seem at first and that community support and goodwill can be easily eroded. As Cruz [41] pointed out, the social acceptance of WE plant is not as problematic as, for example, a wind farm, but cannot be neglected, as there is an increasing public awareness of the enormous potential for the sustainable exploitation of wave power as a benign form of energy.

Installing a shoreline OWC plant energy is a complicated process of design and development, in which there are a large number of technical and social aspects to control, although in this paper we tended to give a major importance to those social and community type. Our empirical case study validates what was noted by Walker [1] almost two decades ago, when he said that the complexity of the task of developing an understanding of "what the public thinks", and of how attitudes are formed, changed and developed in connection with the adoption of renewable energy, must not be underestimated. Even more, due to the "low public knowledge" on WE, it is especially important to be aware of the level of WE understanding in selecting the most appropriate tools for addressing stakeholders [43].

Throughout our research we found that most of the local people interviewed and consulted had little information about the project. Adequate information, in what refers to content and timeliness, can be considered the main source of trust creation in WE project. As was admitted by the promoters of the project Mutriku OWC plant, the planned information strategy had deficiencies. As noted by Torre-Enciso et al. [61] the people of Mutriku had not been told exactly what was being done and what was the construction schedule of the project. They attempted to resolve this deficiency through a communication campaign launched in the town in order to better inform people about the technical characteristics of the project.

Though effective, it is possible that this campaign lacked proper planning and integration into the overall project. As the developers of the project explain, the lesson learnt was as simple as it was important: "If you do not provide sufficient information about your project, others will provide information on your behalf" [61]. In the same line of action, at the time of writing up this paper, there is planned for spring 2013 a guided open information day for people to visit the plant. This day will also be used to collect impressions from citizens on the OWC plant to create exhaustive inventory of their concerns and inconveniences caused to them, with the hope of fixing these problems as much as possible. To do so, the developers of the project intend to place some informative posters, to collect suggestions and distribute a questionnaire that would be completed by the population in attendance.

7. Conclusions

Information and participation have become crucial terms in the implementation of renewable energy infrastructure. In order to build a strong social consensus around these type of projects, such as the WE plant under study in this research work, it is absolutely necessary to develop and information system that guarantees that citizens will be informed promptly about the scope and time duration of the project, the expected performance of the infrastructure and the impact that it will have in their regular life. And, as important as the previous, provide the citizens with a channel for participation, to certain extent, in the decision making process. We can conclude this, despite the particularly positive public opinion that seems to prevail with regard to this source of renewable energy. To this end, the active early consultation, discussion and negotiation with main stakeholders, as well as the proactive provision of full and detailed information to the local community, aiming at promoting a meaningful social involvement, may be crucial for the successful promotion and diffusion of renewable energy technologies. The local and global negative impact, both short and long term, of the deficiencies in the decision-making processes, should not be underestimated, since, as recently stressed by Shamsuzzoha et al. [35], the involvement of the local community plays a decisive role in determining the acceptability of a renewable energy development. Nevertheless, as pointed out by Wolsink [37], public authorities are frequently involved in promoting infrastructures that conflict with their officially proclaimed policy objectives and they often confronted with local actors who support alternatives that are in fact better in tune with the current major trend.

We have identify the necessity of a comprehensive plan that includes all the social and community relationship aspects, in projects similar to the one subject of our research that are characterized by complex institutional, political and cultural environments. To this end it is very important to apply, as recommended in the relevant literature, a dynamic assessment perspective for the renewable energy projects. We need to understand this perspective as a learning process that is highly dynamic, hence that requires a policy analysis to be flexible and adaptive in nature [30]. Likewise, as stressed by Aitken [50], trust has been identified as a key issue for the successful adoption of WE Infrastructures. Trust should flow in two directions in between local stakeholders and project promoters. As highlighted by the above mentioned author, beyond deterministic approaches the promoters of this kind of Infrastructures “should trust the public to have valid opinions and legitimate knowledge and therefore should trust on an open participation that can produce positive outcomes whether or not these are in favor of particular Developments” [50], 2010, p. 1840. In sum, as described by Walker [1] it is important that the potential bases for conflict and opposition against WE plants are carefully examined, and that possible responses to that opposition are provided in order to achieve a broader degree of public consent among stakeholders. As in the case of other renewable energies, in projects related to WE, public involvement is positive in the long run despite the fact that sometimes it may require to extend the timeline to complete the process of public approval [43].

We have identified some limitations to this research work. Some of these limitations are due to the interpretive and explanatory nature of the objectives of our project and to the use of a qualitative study methodology. The community acceptance of a WE plant is a very complex, dynamic and multi faceted issue. In this sense, there could be contingential factors that might affect substantively the snapshot of the social situation that could be harvested considering one specific place and time. For instance, the fact that the interviews have been conducted during a period of serious economic crisis, in which the renewable energy projects have suffered the public budget cuts, may also have led to a certain bias in the results obtained. In relation to this, and according to the findings obtained in this paper, we can state that a more specific research is needed to explore the role of these contingential factors in the dynamics of the community acceptance of renewable energy projects. Then, as proposed by Devine-Wright [42], a more explicit and in depth investigation of the interactions between social values and different types of place attachment of renewable energy projects seems to be necessary to fully understand the impact of social cultural profile and social acceptance of WE projects.

Looking into the future, many other aspects related to the social acceptance of WE could be analyzed. The aforementioned local and global negative impact, both short and long term, consequence of the deficiencies in the decision-making processes should be analyzed in depth. For this reason, research projects such as the EU funded SOWFIA project – aimed at providing recommendations for the streamlining of public and stakeholder approval processes for wave energy developments across Europe – should be widely encouraged and promoted [63].

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Annex. Interview protocol: guidelines for the semi-structured interviews.

Section 1: *Context of the adoption of the OWC Shoreline Plant*

- Main agents/actors and their power of negotiation, perceived interests, etc
- Main changes and challenges in the past (forces, objectives, etc.)
- Future trends (reasons, objectives, challenges, etc.)

Section 2: *Motivation and adoption process of the OWC Shoreline Plant*

- External and internal motivation behind adoption
- Main obstacles to and benefits of adoption
- Influence of the adoption on different aspects of the every day life
- Consequences of changes to people

Section 3: *Public debate, in favor and against, of the OWC Shoreline Plant*

- Main social and public attitudes in favour
- Main social and public attitudes against

Section 4: *Other personal experience with the OWC Shoreline Plant*

- Unstructured narration of the experience

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